Appendix C

Examples of Folds and Faults in Columbia River Basalt Group Flows from the Columbia Basin

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This appendix provides examples of Yakima folds and the smaller-scale geologic features that are found in the fold belt.

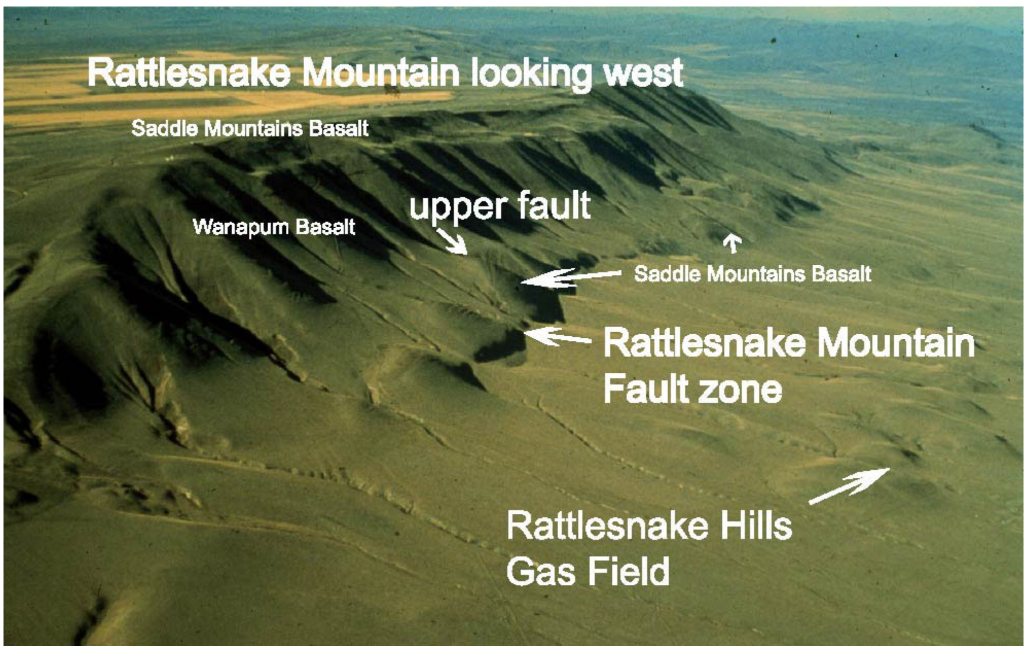


Figure C.1. Rattlesnake Mountain as Viewed from the East and Looking West. The main fault zone is visible at the base of the ridge. The scarp is actually hogbacks of the Elephant Mountain Member (10.5 Ma) tilted northeast. Rattlesnake Mountain is one of the highest Yakima fold with the crest of the ridge at 3600 feet elevation.

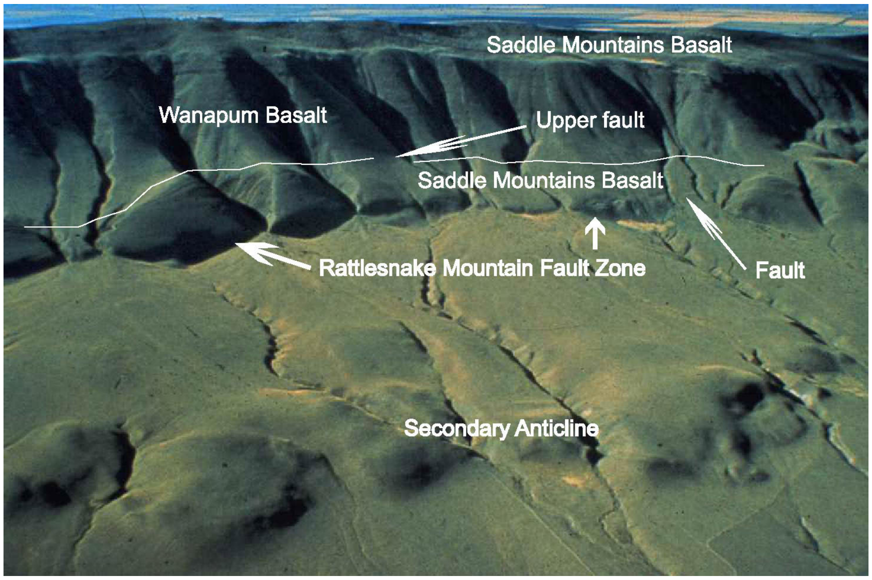


Figure C.2. Rattlesnake Mountain Looking Southwest. The secondary anticline is the Rattlesnake Hills gas field.

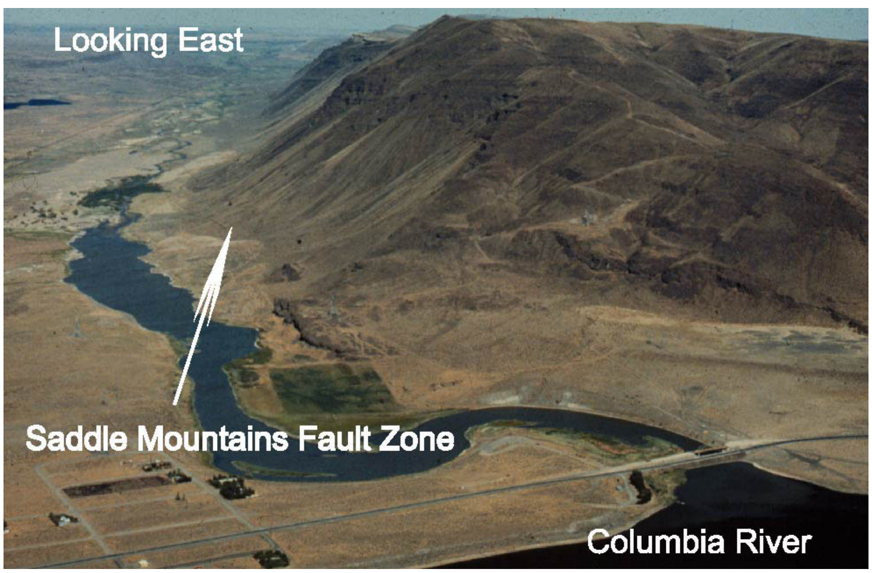


Figure C.3. Saddle Mountains Anticline Viewed from the West. The Priest Rapids Member (14.5 Ma) makes the surface rock in Crab Creek and the top flow at the highest pointing the foreground.

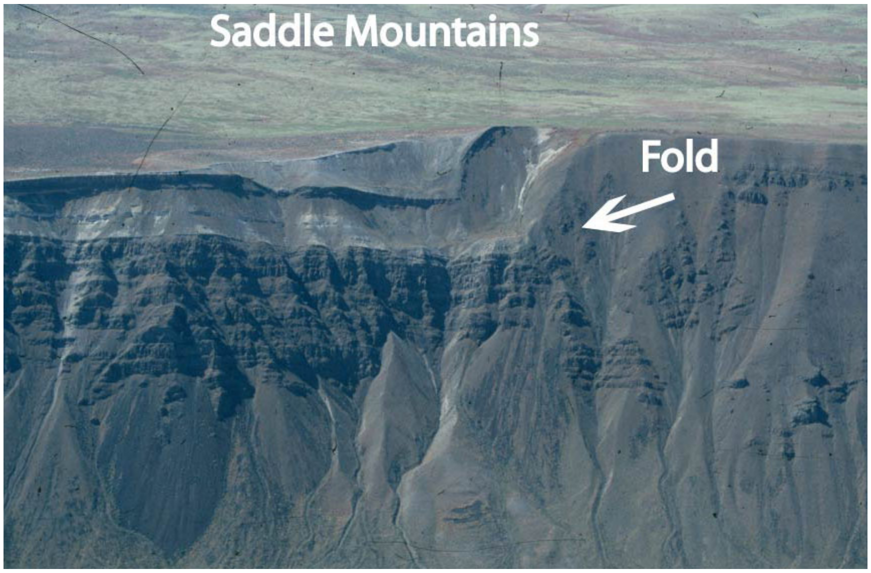


Figure C.4. Small Fold on the North Face of the Saddle Mountains. No fault could be found at this sharp bend. The uppermost resistant ledge in the fold is the Elephant Mountain Member (10.5 Ma) intercalated with Ellensburg Formation sediments forming a small basin.

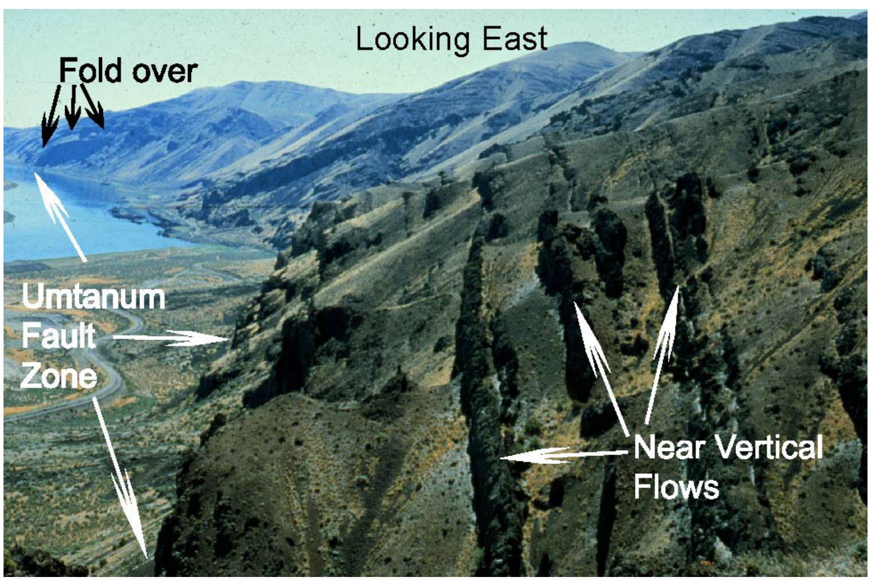


Figure C.5. Umtanum Ridge Anticline Viewed from Near Priest Rapids Dam

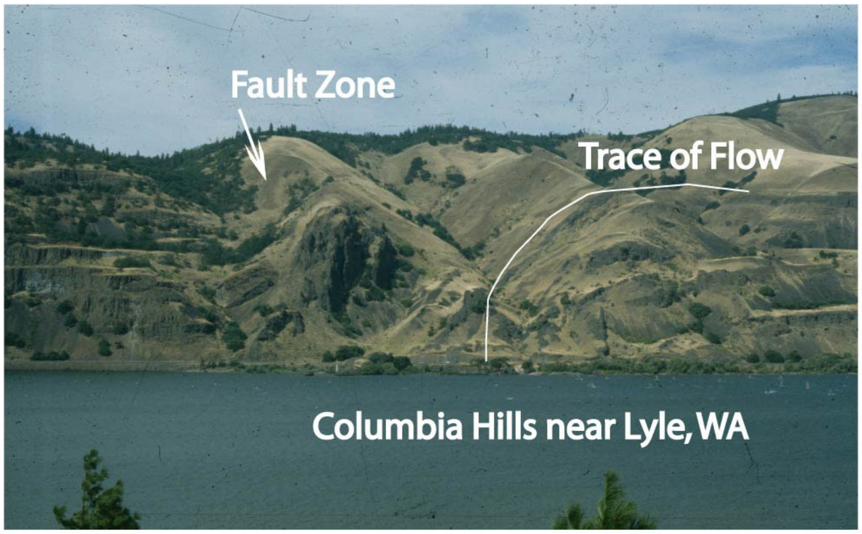


Figure C.6. Columbia Hills Anticline and Fault Where it Crosses the Columbia River on the East End of the Columbia Gorge

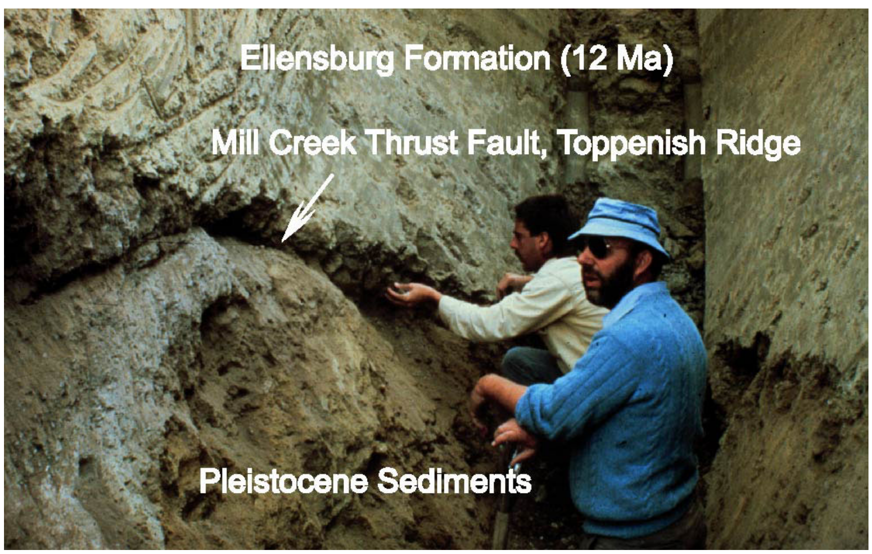


Figure C.7. Mill Creek Thrust Fault Exposed in Trench Cut into Toppenish Ridge. Movement of the upper plate is to the north (out of the page).

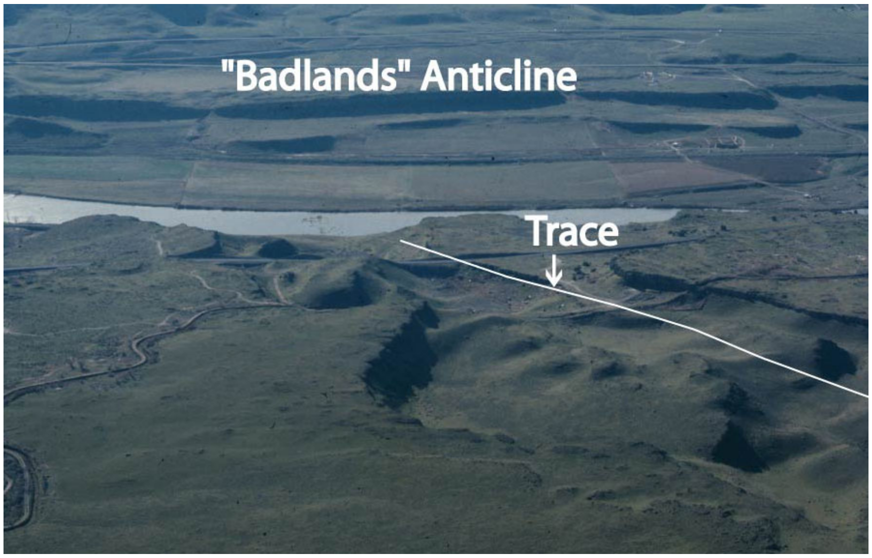


Figure C.8. Badlands Anticline. The badlands anticline is the northwest extension of the northwest segment of the Horse Heaven Hills anticline west of Benton City, Washington. View if from the north to the south along the Yakima River.

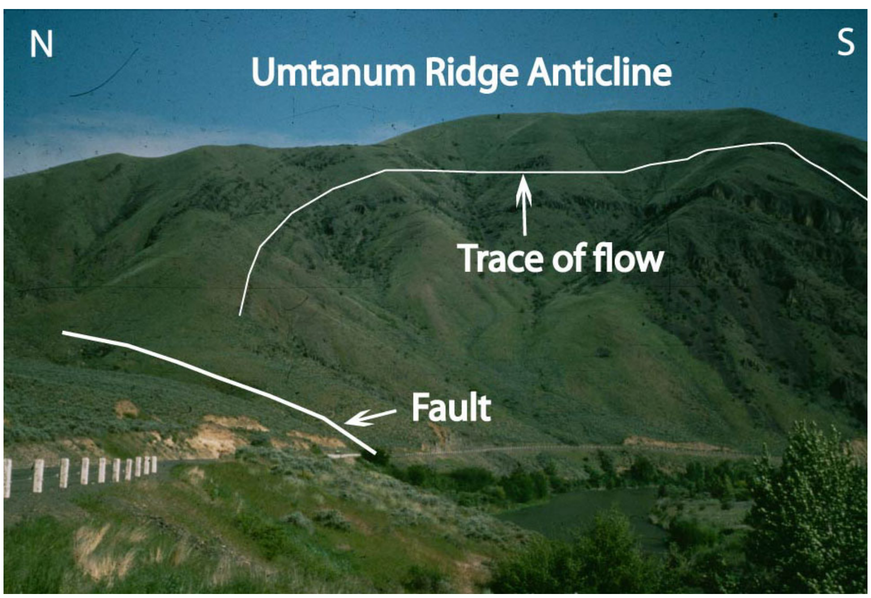


Figure C.9. Cross Section Through Umtanum Ridge Anticline in the Yakima River Canyon North of Yakima Washington

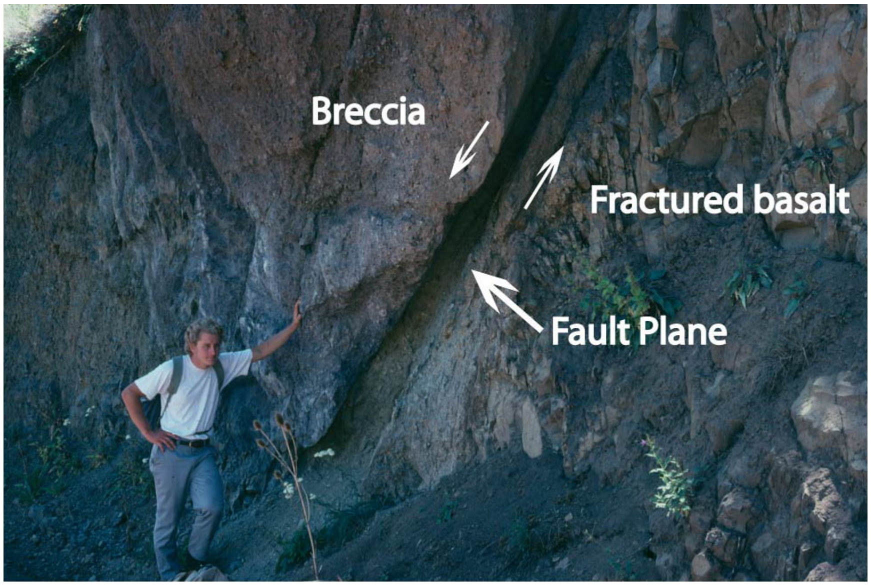


Figure C.10. Normal Fault in Grande Ronde Basalt from the Snake Canyon, Oregon-Washington-Idaho border. Note brecciated hanging wall.

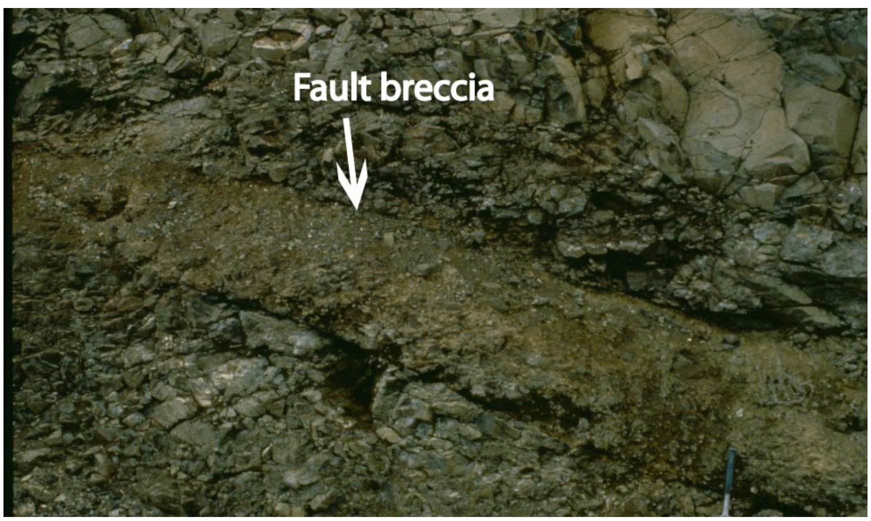


Figure C.11. Small Thrust Fault Zone in Basalt. Note pen in lower right for scale. Note brecciated nature of fault gouge.

Figure C.12. Badger Mountain Looking Northwest. Badger Mountain is one of the small doubly plunging anticlines along the Rattlesnake-Wallula alignment in the Central Columbia Basin.

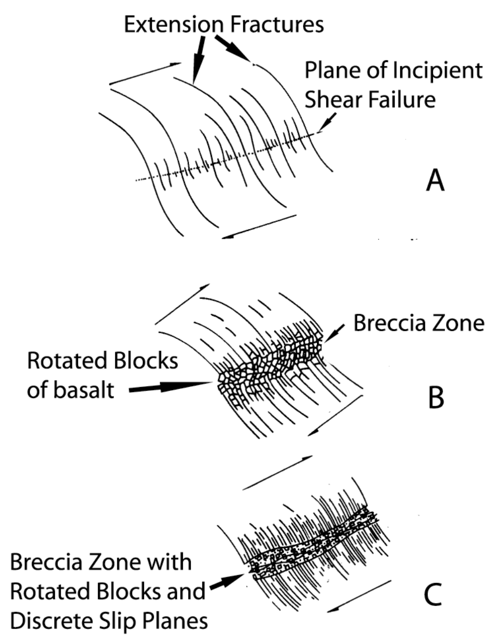


Figure C.13. Three Stages of the Development of a Breccia Zone (Price 1981). A. development of incipient shear zone. B. Shear zone begins to brecciate and blocks begin to rotate. C. Breccia zone with rotated blocks and discrete slip planes. See Figure C-13 through C-18 for field examples from the development of these stages.

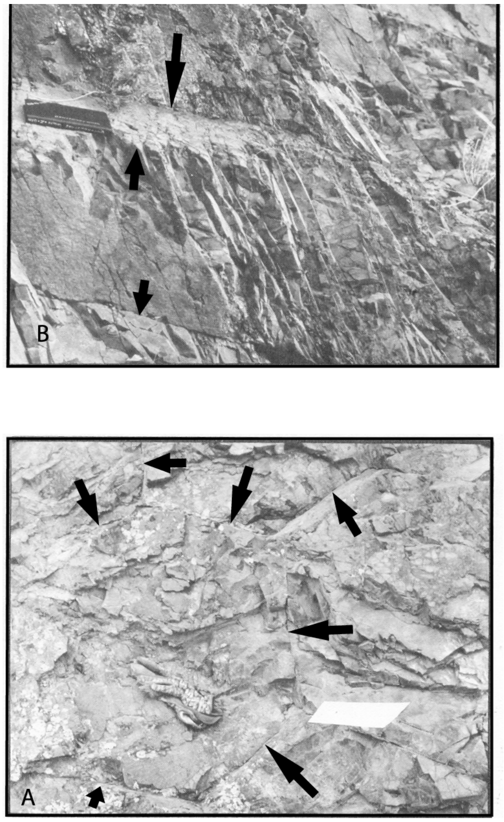


Figure C.14. Shattered Cooling Columns During Stage A of Figure C.13 (Price 1981). A. End view. Arrows show cooling fractures. B. Shattered brecciated columns lie on column face.

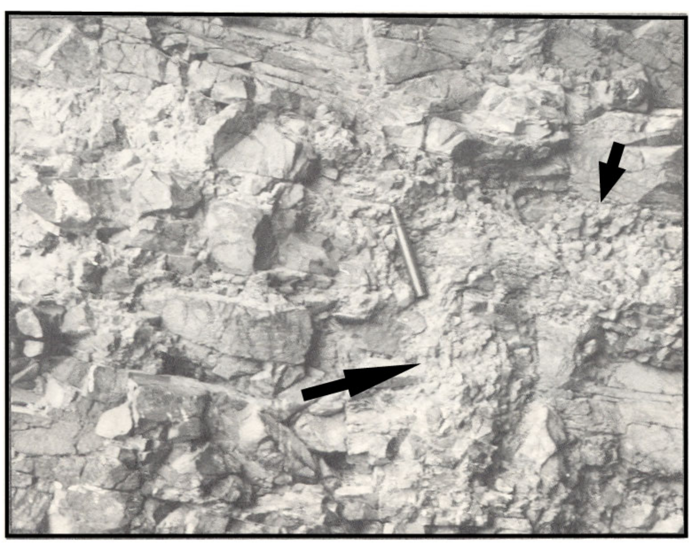


Figure C.15. Anastomosing Breccia Begins to Develop (Price 1981). Stage B Figure C.13.

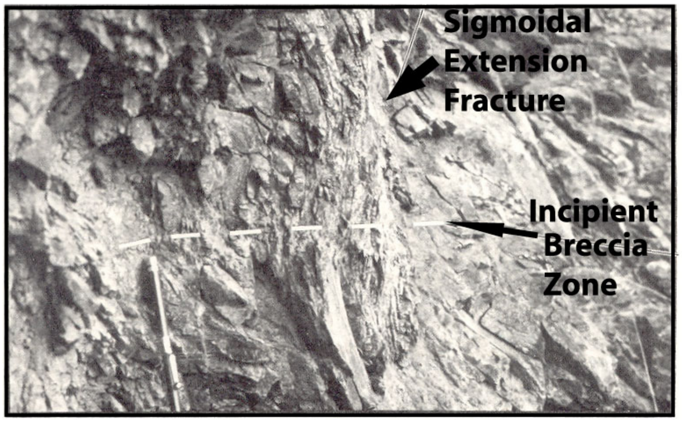


Figure C.16. Sigmodial Extension Fractures Develop as Rotation Begins (Stage B, Figure C.13) (Price 1981)

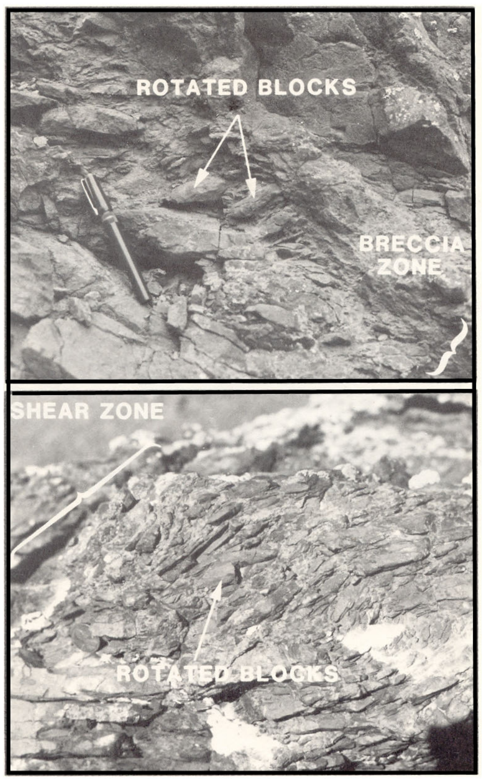


Figure C.17. Rotation of Blocks (Stage B, Figure C.13) (Price 1981)

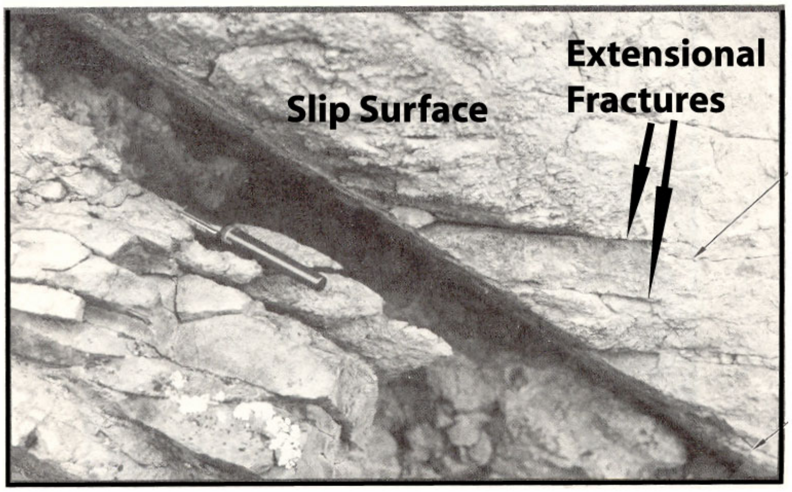


Figure C.18. Stage C, Figure C.13. Development of discrete slip surface (Price 1981).

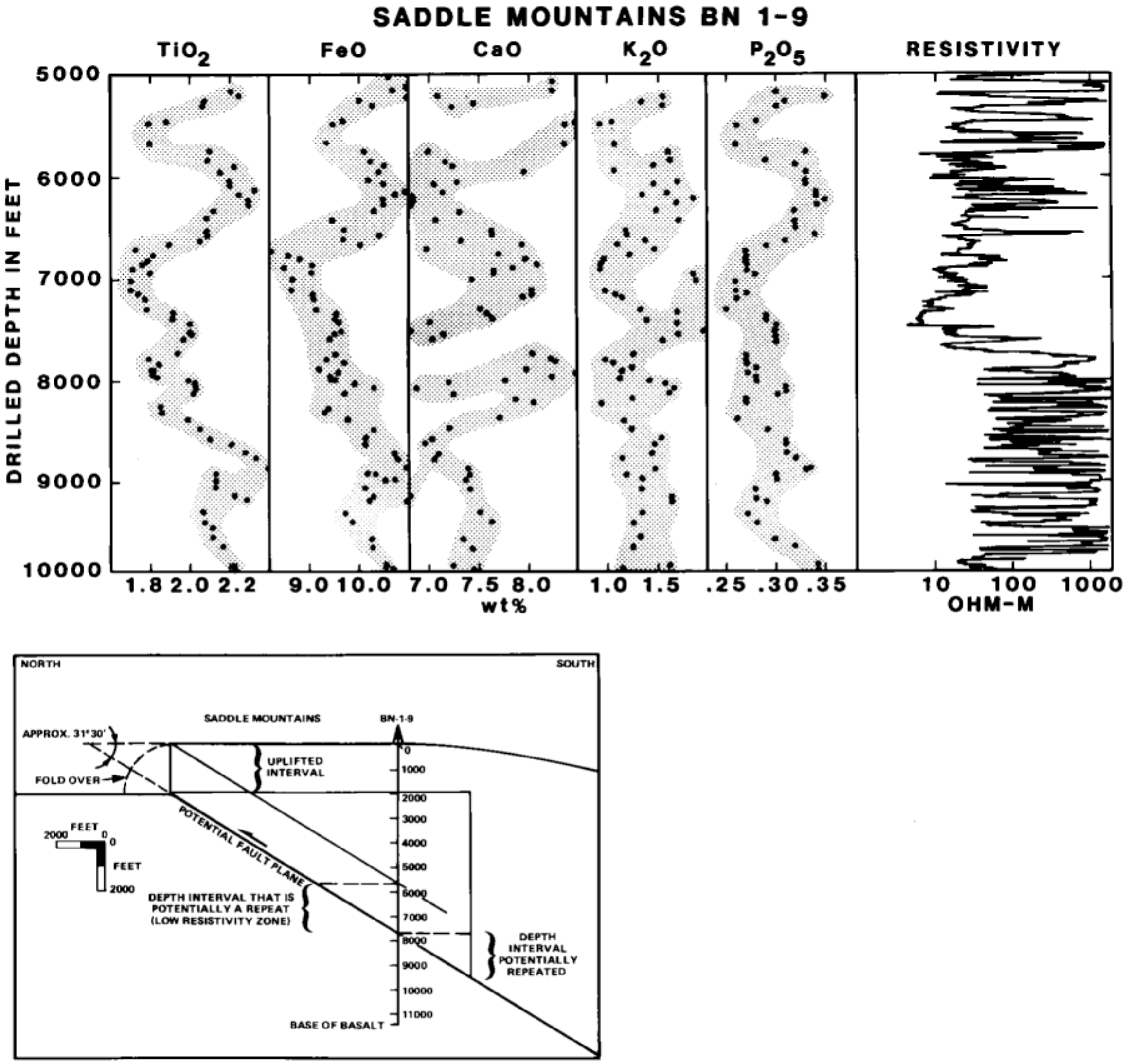
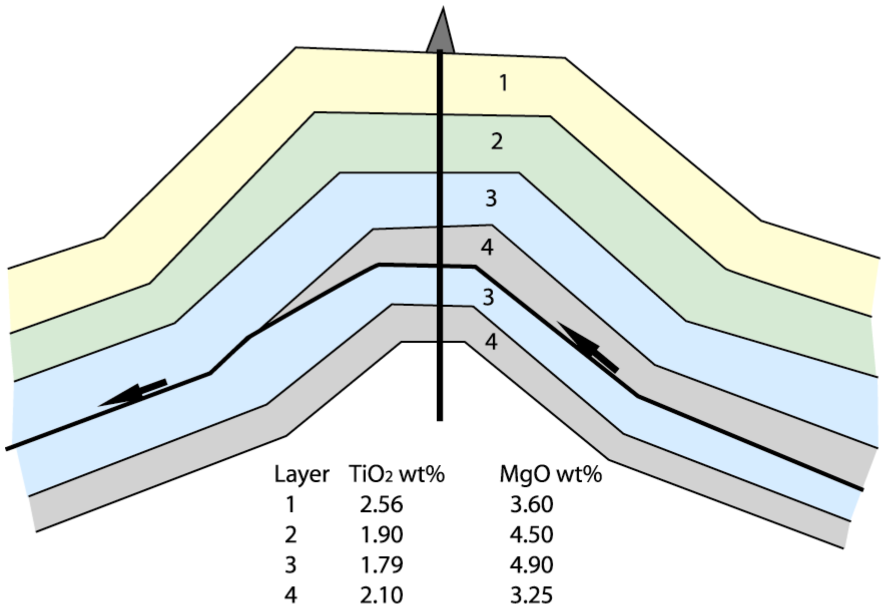


Figure C.19. Use of Chemistry for Determining if the Basalt Stratigraphy has Been Repeated Due to Faulting (from Reidel et al. 1989). The lower figure shows a no vertical exaggeration diagram of the Saddle Mountains with borehole 1-9 BN. The resistivity log suggests fracturing and potential faulting between 7,000 to 8,000 feet (low resistivity). The chemical diagrams show that there is no repeat in the chemistry of the flows indicating that there is no significant repeat in the stratigraphy due to faulting.



Layer	TiO_2 wt%	MgO wt%
1	2.56	3.60
2	1.90	4.50
3	1.79	4.90
4	2.10	3.25

Figure C.20. Use of Chemistry for Determining Repeated Stratigraphy Due to Faulting. In this example, two flows (3 and 4) have been repeated by faulting and the chemistry shows the repeat. If chip samples were analyzed from the lava flows penetrated by the borehole, then chemistry of lava flows 3 and 4 would be repeated. To effectively use chemistry for identifying a repeated stratigraphy, the proper stratigraphic order would have to be known, including the lava flows below 4. A comparison of the "predicted" stratigraphy to the "actual" stratigraphy would then show the repeated lava flows. Establishing the "expected" stratigraphy for an area is discussed in Appendix G.